

Tegmina and wings pale hyaline, the venation olivaceous or fuscous.

The rostrum does not extend beyond the intermediate coxæ and the face is laterally coarsely striated.

Long. excl. tegm., ♀ 12 millim., exp. tegm. 37 millim.

Hab. Cashmere Valley, 6300 feet (*Leech*). *Coll. Dist.*

LI.—*Remarks on Shell-growth in Cephalopoda.*

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THE structure of the "shell" of a *Sepia* is so unlike that of the *Nautilus* that any serious attempt to work out their homologies must be heartily welcomed by all who are interested in Cephalopoda. The *Sepia* is much the harder of the two to understand, and well deserves the study that has recently been bestowed upon it by Riefstahl* and Bather†. Unfortunately these descriptions of the soft parts within it do not agree, though the difference is not on a point of very great importance.

It does not appear, however, that these studies throw much light on the question from a geological point of view. That is to say, we get no nearer understanding how a *Nautilus*- or *Ammonite*- or *Belemnite*-shell is actually formed. When I was writing the Introduction to my 'British Fossil Cephalopoda,' some six years ago, I examined the structure of the *Sepia* with a view to obtaining light from it, and got as far as the above-named writers have in the knowledge of the hard parts, yet found no means of homologizing them with those of a *Nautilus* or *Belemnite* with any approach to conviction. Nor do I find that these writers have anything definite to add, but help themselves along by theory, even without testing it by available facts. I wish to deprecate this method in the interests both of the subject and the workers. In the first place, it is not *inductive* science; and in the second the author of a supposed genealogy will find it very awkward when further knowledge—and that not hard to acquire—shows the facts to be dead against him. But most of all it is to be deprecated for the damage it does to the credibility of what are meant to be stated as facts by such writers, as we never can tell whether what they say is from autopsy or from mental conception.

* *Palaontographica*, Bd. xxxii. 1886.

† 'Annals,' April 1888, p. 298. See also *Geol. Mag.* 1887, p. 446.

Whether the successive layers of the spongioid-tissue or "pad" of the Sepion is formed by intussusception, as Riefstahl says, or by successive formation of chitinous membranes by the epithelium of the shell-sac, as Bather says, is, after all, only a matter of argument, in which the latter seems to me to have the best of it. If we are to get any further, we must have some *evidence* of the homology between these layers and the parts of any other Cephalopod. It is *assumed* that these layers correspond to the septa of a Nautilus or of the phragmocone of a Belemnite. But do they? They have no siphuncle, and they are not even perforated. Yet a siphuncle and neck are present in Nautilus, Ammonite, Belemnite, and Spirula, and, what is more remarkable, though the Nautilus commences with a cap and the other three have a well-marked nucleus, nothing of this sort has yet been discovered in Sepia. I specially looked for it, but could find no representative of such a structure. On the other hand, if Mr. Bather had availed himself of my observations of the shell of Nautilus, of which he seems to be ignorant, or had made observations for himself, he could not have written as he does, nor could M. Riefstahl have supposed for a moment that the Nautilus-shell grows by intussusception between the septa. On page 17 *et seq.* of my work I give a very detailed description of the structure of this shell.

I there show that the shell proper is composed of three layers: the outer, a porcellaneous one, is formed of large radiating crystalline particles set in a dark ground-mass, which, if they show any orientation, are perpendicular to the surface; and this layer is not at all divisible into laminae. It shows lines of growth on the surface, and these pass marginally, and not superficially, into any fractures that may have taken place in the growing edge of the shell. These characters leave little doubt that this layer is formed by secretion at its bounding edge. Very different is the middle layer. It has, as Hyatt pointed out, an imbricated structure, a structure which might very well suggest the pad of the Sepion as its homologue. This imbrication is in truth excessively fine, as about a thousand fine laminae may be counted in its thickness; the outcropping edges of these, being about 20,000 to the inch, diffract the light and give rise to the nacreous lustre, when the innermost layer is absent or worn away. The direction of these laminae is outwards in the direction of the aperture of the shell. Their obliquity is very slight, so that in tracing them from their commencement inside to their termination against the outer layer of the shell, they pass more than one septum, and must therefore have been

formed previously to the septa they pass. They are sprinkled more or less closely by minute dark spots, with irregular radiations, like the lacunæ of a bone, which may have a formative function. Again, some of these laminæ start from the inside of the body-chamber remote from the last septum, as indeed it is obvious they must do, as the nacreous surface formed by them is not confined to the camerated portion of the shell. We may conclude from this that they are formed by the *surface* of the front part of the body-covering or mantle, and would be formed whether there were any septa or not. They are also formed successively, and as they are not devoid of animal substance, we may perhaps say they are at first "chitinous" membranes subsequently calcified, and that they do not grow by intussusception. The third layer is a thin amorphous substance covering the whole of the interior of the shell. It is excessively thin, and though quite invisible, if present, in the earliest chambers, is well marked in the later portion of the shell, especially where the septa abut on the shell-wall. It is here seen *between the septum and the shell*, completely separating the two structures. It is thus seen that the statement by Mr. Bather ('Annals,' p. 306)—that "secretion and exfoliation, beginning in the anterior region of the shell-wall, proceed backwards to the suture; thence, centripetally over the septum, to the posterior margin of the septal neck; a membrane of the septum is therefore one with a membrane of the shell-wall, and each complete membrane is typically shaped like a funnel,"—either is entirely imaginary, or my observation, which I have just verified again, is erroneous.

The structure of the septum is different from that of the shell, though it is on the same type as the nacreous layer. It is composed of a large number of equally fine laminæ, also speckled with lacunæ; but the laminæ do not crop out on the surface, but are parallel to it; there is therefore no diffraction of light, but a peculiar pearly lustre, due to the minute floating specks, just as in a pearl, or at least as in an artificial pearl whose lustre is similar to that of a natural one. It thus differs from the nacreous layer, just as pearls do from mother-of-pearl. I judge this to have been formed in the same way, by secretion from the surface of the body-covering in contact with it.

These observations do not lend much countenance to the idea that the laminæ in the pad of the *Sepia* are homologous with the septa of a *Nautilus*, nor, therefore, with those of the phragmocone of the *Belemnite*. If one might venture a guess, in the absence of more precise proof, it would appear

rather that the imbricating laminae of the pad of the Sepia may be homologous with the imbricating laminae of the nacreous or middle layer of the Nautilus, but far more loosely aggregated, and thus that the Sepia, instead of being a closed tube, like the Nautilus or Belemnite, is an open or boat-like structure; and this would account for the absence of any cap or nucleus in the former—those structures being essentially related to the formation of a closed tube—and their homologues would be sought in the open spoon-like commencement of the Sepia, which is clothed round by the mucro. In this view the outer layer of the Nautilus-shell would be represented by the middle layer of the Sepia, a correlation less difficult on account of its excessive thinness in Ammonites and Belemnites; and hence the guard of a Belemnite and the shagreen-layer of Sepia are adventitious superadded structures, unrepresented in *Spirula* and probably in *Loligo*.

If there is any truth in this, then the approximation or otherwise of the septa of the Nautilus will have little to do with the question; moreover, if it has, the observations of Mr. Bather are too partial to be of value, either in relation to the living Nautilus or its extinct congeners. One would suppose from his statement that in a Nautilus the earlier septa are approximate, the middle ones far apart, and the later ones approximate again, and he derives a confirmation from this of the theory, which is doubtless often true, that the characters of senility resemble those of youth. As to this I may quote the following passage from p. 30 of my work:—"Starting from the first septum, we do not find them at distances constantly proportional to the diameter. If they were, there would always be the same number in each whorl. In an example, however, of *Nautilus pompilius* the first whorl has eight chambers, the next sixteen, and the last *half* whorl seven. The same want of regularity is found in other Nautiloids. As a rule the earlier septa are more remote, and the middle ones only retain for some distance their proportionality. The last two or three septa of the adult very commonly differ in distance from the rest. In some rare cases they are more remote, but they are usually closer, and the commonest case is that in which the last one is at half the usual distance."

Again, as to the history of any genus. I should like Mr. Bather to look at the septa of *Goniatites sagittarius* of the Devonian, so crowded one can scarcely count them—yet it is not the earliest *Goniatites* by far, nor yet the last—and then see if he can maintain the statement that "so early as the *Goniatites* the septa are far apart in proportion to the diameter of the whorl." In fact the distance of the septa seems to be

an adaptive character, related to the breadth of the whorl, almost all coiled Cephalopods which have wide whorls having approximate septa and *vice versa*.

Although therefore a new student of the Cephalopoda is to be welcomed, as there is plenty of work to do, it would be better that such a one should take up the story where others have left it than go over the old ground with preconceived theories and less careful observations. Nothing, in fact, in the present communication is new; though it may be little known, it was all in print six years ago.

I am not at all sure, however, that the suggestion to divide the Cephalopods into three primary groups, Ammonoidea, Nautiloidea, and Coleoidea, instead of into two, the Tetrabranchiata and the Dibranchiata, is not a good one. We really do not know that the Ammonites were tetrabranchiate, and by the old subdivision we assume they were. But is Coleoidea a good name? No doubt Sepia and Belemnites have a "sheath," but has Spirula, or Loligo, or Octopus? How would Belemnitea do? The zoologists might not like it; but then it is more natural to name children after their parents than *vice versa*. And from its relation to terms already in use and its congruity with the other two every one would know what was meant.

BIBLIOGRAPHICAL NOTICE.

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In this part of the 'Transactions' of the local societies of Cumberland and Westmorland the contributions of purely literary and antiquarian interest and those dealing with scientific subjects are exactly in equal numbers. Of the former, although they are of considerable general interest, we need say nothing here; of the latter, one is the "Zoological Record for Cumberland, 1886," by the Rev. H. A. Macpherson and W. Duckworth, and the other bears the title of "Our Summer Visitors," by Mr. Tom Duckworth, and is in continuation of previous communications by the same writer. The former is a record of the occurrence and breeding of certain species of birds in the district, to which are added notes on the habits of several of the species and on some of the Mammalia of Cumberland. In the latter we have a series of notes upon several of the birds which visit the district in the summer—the Ring Ouzel, the Wheat-ear, the Nightjar, the Landrail, and the Common Sandpiper.